



## Generator Vehicle Level Noise Evaluation Procedure

### 1 Introduction

**Note:** Nothing in this standard supercedes applicable laws and regulations.

**Note:** In the event of conflict between the English and domestic language, the English language shall take precedence.

**1.1 Purpose.** Determination of vehicle interior generator noise, at idle and during acceleration.

**1.2 Applicability.** This procedure applies to vehicle tests for all non-hybrid passenger cars, multi-purpose passenger vehicles, minibuses and light commercial vehicles equipped with engine driven electro-mechanical devices used to supply the electrical system with electric energy and to recharge the battery.

**1.3 Remarks.** None.

### 2 References

**Note:** Only the latest approved standards are applicable unless otherwise specified.

#### 2.1 External Standards/Specifications.

IEC 60651

#### 2.2 GM Standards/Specifications.

GMW14036

GMW14172

GMW16178

#### 2.3 Additional References.

- Dynaload equipment available at <http://www.filterconcepts.com/ecatalog/dynaload/RBL488-100-600-4000>
- Pulse Width Modulation (PWM) controller available at [www.appliedprocessor.com/ordering-information.html](http://www.appliedprocessor.com/ordering-information.html)

### 3 Resources

**3.1 Facilities.** All measurements shall be performed in a semi-anechoic chassis dynamometer test room.

**3.1.1 Calibration.** The test facilities and equipment shall be in good working order and shall have a valid calibration label.

**3.1.2 Alternatives.** Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

#### 3.2 Equipment.

**3.2.1 Tachometers.** Two (2) tachometer signal probes capable of providing a 1 pulse/revolution signal of the generator and engine crankshaft.

**3.2.2 Data Acquisition System.** A microphone regionally accepted for vehicle interior measurements with data acquisition hardware, reference GMW16178.

**3.2.3 Data Analysis System.** Multi-channel data acquisition hardware capable of calculating frequency domain results between 0 Hz and 22 387 Hz, with a frequency resolution 1 Hz, and a minimum dynamic range of 80 dB is required. This hardware shall meet class 1 accuracy corresponding to IEC 60651.

**3.2.4 External Electronic Loading Device.** A device capable of controlling the electronic load applied to the generator such as the Dynaload model **RBL488** 100-600-4000 (see 2.3).

**3.2.5 Current Metering Device.** Use a Direct Current (DC) and Alternating Current (AC) (0 Hz to 6400 Hz) capable Inductive current clamps to measure current. Use a current clamp with at least a 300 A range and a tolerance  $\pm 2\%$ .

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**3.2.6 Thermal Couple.** Thermal couples are used to measure the generator case temperature and air temperature near the regulator.

**Note:** Temperature equipment tolerance  $\pm 1$  °C.

**3.2.7 Pulse Width Modulation (PWM) Controller. (For GM-Regulated Voltage Control (RVC).)** A device capable of variable frequency and duty cycle control of PWM signal to the generator such as the Model 205 PWM Controller (see 2.3) is required for generators that use PWM control.

**3.3 Test Vehicle/Test Piece.** The test shall be performed on a vehicle which represents the current release status. Eliminate any inappropriate content or unwanted problems. Check door sealing and possible acoustic package leakage. Verify and note the status of all hardware relative to the current release status.

**3.3.1** Record Vehicle Identification Number, GM fleet number and the build stage if appropriate. Record generator brand, model and part identification. Record generator characteristics, such as, nominal current, number of poles, stator slots and fan blades. Record the testing date, time and location. For an example, see Appendix D, Data Sheet D1.

#### 3.4 Test Time.

Calendar time: 1 day

Test time: 6 hours

Coordination time: 2 hours

**3.5 Test Required Information.** Obtain the generator load curve (current versus Generator revolutions per minute (Grpm)) at working temperature or at other specified condition.

**3.6 Personnel/Skills.** One (1) engineer or qualified technician trained in the use of data acquisition equipment and with basic knowledge of acoustics and signal processing and a chassis dynamometer operator.

## 4 Procedure

**4.1 Preparation.** Ensure that the vehicle meets the requirements outlined in 3.3.

#### 4.2 Conditions.

**4.2.1 Environmental Conditions.** The ambient air temperature shall be  $22\text{ °C} \pm 2\text{ °C}$ .

**4.2.1.1** All interfering noise emissions from test stand devices must be eliminated.

**4.2.2 Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

#### 4.2.3 Define Generator Load Conditions.

**4.2.3.1 Condition A: Generator No External Load.** No external load applied to the generator.

**4.2.3.2 Condition B: Generator Full Load.** Measure the generator speed, in Grpm, with the vehicle at idle or calculate this speed from the nominal idle engine speed and pulley ratio. Use the generator load curve, as specified in 3.5, to select the current load that corresponds to the generator speed at idle. That load will be used for the Generator Full Load condition.

#### 4.2.4 Standard Test Conditions.

**4.2.4.1 Idle Steady State.** Generator magnetic whine noise is measured at vehicle idle, or identified off idle steady state engine speeds of interest for generator noise, at the following generator loading conditions:

- **Condition A:** Generator No External Load
- **Condition B:** Generator Full Load

**4.2.4.2 Speed Sweep.** A fixed speed controlled engine/generator sweep down is used to capture generator noise. Repeat the speed sweep for each of the following generator loading conditions:

- **Condition A:** Generator No External Load
- **Condition B:** Generator Full Load

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### 4.3 Instructions.

**4.3.1 Set Up Vehicle in Test Cell.** Set up vehicle in test cell as required. Hook up exhaust collectors. Install engine emergency shut off and throttle controller.

**4.3.1.1** Adjust the seats and headrests according to Appendix A. Close all windows, sliding roofs and sunscreens.

**4.3.1.2** Install a current metering device at the generator positive output. Install an external electronic load device, at the vehicle battery terminals. Reference Appendix B, Figure B1.

**4.3.2 Calibration Verification.** Check equipment for valid calibration date. Replace out of date equipment. Turn on all equipment and leave on for 5 minutes prior to measurements or calibration. Perform microphone calibration verification. Reference GMW14172.

**4.3.3 Install Instrumentation.** Install tachometer probe or optical pick up to accurately capture the generator speed, in Grpm and engine revolutions per minute (Erpm).

**4.3.3.1 Install Measurement Instrumentation.** Position the microphones to be consistent with GMW16178.

**4.3.4 Generator Output Control.** Maximum load is measured by setting the generator constant rotation speed at 7500 Grpm on a  $22\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$  environment temperature and by increasing the electrical load until the generator output voltage drops 0.25 V. Record the current measured by current meter on that condition and use it as generator full load condition.

Control the generator output as defined in the following:

**4.3.4.1 RVC Voltage Regulators.** PWM signal (5 V square) and 60% Duty Cycle-standard voltage output is 13.8 V. Reference GMW14036 and Appendix C, Figure C1.

**4.3.4.2 Non-RVC Voltage Regulators/Generators.** For Non-RVC Voltage Regulators/Generators, request a circuit diagram and controls from the generator supplier to provide the desired output voltage. For non-RVC voltage regulators/generators that cannot set voltage equal to RVC 60% duty cycle, set to 13.8 volts then match equivalent power output. For Non-RVC applications, the low load can be 0 watts to 300 watts. The 60 amp  $\pm 2$  amp load or 800 watts to 850 watts load requires the load to stay within the range over the sweep.

**4.3.5 Measurement.** Warm up the vehicle before starting test. Ensure engine cooling fan does not turn on during data acquisition.

**4.3.5.1 Idle Noise Measurement.** Operate the vehicle at nominal idle, or any identified off idle speed of interest for generator noise, at the following generator loading conditions:

- **Condition A:** Generator No External Load
- **Condition B:** Generator Full Load

**4.3.5.1.1** Set up the data acquisition system to acquire data capable of providing steady state narrow-band data using the following parameters:

- Frequency Range: 0Hz to 20 kHz
- Frequency Resolution: 1 Hz
- Window: Hanning, Energy Correction
- Amplitude: Root Mean Square (rms)
- Averaging: 50 averages, 50% overlap
- Acquire data at each loading condition

**4.3.5.2 Sweep Down Measurement.** Determine the Road Load Simulation (RLS) Coefficient as per GMW16178 and set it on dynamometer. Put the vehicle in 2<sup>nd</sup> gear (or equivalent) gear. Sweep down from Wide Open Throttle (WOT) shift point (reference GMW16178) to Off-Brake Speed.

Set up the data acquisition system to acquire data capable of providing the following generator speed based data:

- Overall A-weighted sound pressure
- A-weighted sound pressure order cuts at prominent generator orders with a bandwidth of 0.1

Acquire data from engine WOT shift point (reference GMW16178), to Off-Brake Speed:

- **Condition A:** Generator No External Load

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